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1. Your reference	P0993.GBA
2. Patent application number *(The Patent Office will fill in this part)*	0207171.0
3. Full name, address and postcode of the or of each applicant. *(underline all surnames)*	ALSTOM (Switzerland) Ltd Brown Boveri Strasse 7 5401 Baden Switzerland
Patents ADP number *(if you know it)*	8259186004
If the applicant is a corporate body, give the country/state of its incorporation	Switzerland
4. Title of the invention	GAS TURBINE ROTOR BLADES AND STATOR VANES
5. Name of your agent *(if you have one)*	LOVEN & CO
"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	Quantum House 30 Tentercroft Street LINCOLN LN5 7DB
Patents ADP number *(if you know it)*	4467460003

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number	Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if: (a) any applicant named in part 3 is not an inventor, or (b) there is an inventor who is not named as an applicant, or (c) any named applicant is a corporate body See note (d))*	Yes

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	0
Description	4
Claim(s)	1
Abstract	1
Drawing(s)	2 +2

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	1
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature

Date 26 March 2002

12. Name and daytime telephone number of person to contact in the United Kingdom — **K J Loven (01522 801111)**

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Notes

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c) If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.

d) If you have answered 'Yes', Patents Form 7/77 will need to be filed.

e) Once you have filled in this form you must remember to sign and date it.

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DUPLICATE

GAS TURBINE ROTOR BLADES AND STATOR VANES

Field of the Invention

The present invention relates to gas turbine rotor blades and stator vanes, and to impingement tubes used in turbine rotor blades and/or stator vanes for cooling purposes.

Background to the Invention

Modern gas turbines often operate at extremely high temperatures. The effect on the turbine blades and/or stator vanes can be detrimental to the efficient operation of the turbine and can, in extreme circumstances, lead to distortion and possible failure of the blade or vane. In order to overcome this risk, high temperature turbines may include hollow blades or vanes incorporating so-called impingement tubes. These are hollow tubes that run radially within the blades or vanes. Air is forced into and along these tubes and emerges through suitable apertures into the void between the tubes and the inner surfaces of the hollow blades or vanes. This creates an internal air flow to cool the blade or vane.

Normally, blades and vanes are made by casting. Impingement tubes may be inserted into the hollow structure from one or other end and welded or otherwise fixed in place. Chordal ribs are also often cast inside the blades, mainly to direct coolant and to provide a greater cooling surface area. These ribs, or specially cast ribs, may serve as location spacers for the impingement tubes, so as to create the necessary internal space for the cooling air.

Problems arise with fitting impingement tubes into the latest generation of blades or vanes in that the aerofoil sections of the blades or vanes may be extremely complicated. Hollow aerofoils may feature multidirectional curvature. In some designs, the mid section may actually be smaller than either the tip or hub sections. A technique for enabling an impingement tube to be fitted inside such a hollow turbine blade or vane is therefore a necessity.

Summary of the Invention

Accordingly, the present invention provides a turbine blade or vane comprising an impingement tube located generally in a radial direction within the blade or vane, the

impingement tube comprising two parts, extending into the blade or vane from opposite radial ends thereof.

The invention also provides an impingement tube for location within a hollow blade or vane of a turbine, the impingement tube comprising two sections adapted to be inserted into the hollow blade or vane from opposite radial ends thereof.

Preferably, the interior of the blade or vane includes at least one chordal rib adapted to locate the adjacent ends of the sections of the impingement tube.

The rib may be discontinuous. It may have a chevron-shaped cross-section so as to engage the said adjacent ends of the sections of the impingement tube, whereby to minimise air leakage between said ends or, alternatively, to provide a predetermined air leakage.

At least one of the adjacent ends of the sections may have an end wall thereacross. Where both adjacent ends are closed, the sections do not need to fit together. Apertures may be provided in or adjacent to the or each end wall to allow cooling air to exit the sections and impinge on the inner surface of the blade or vane near the mid-height region thereof. The apertures may be directed normally or, more preferably, at an angle and so as not to be disposed opposite corresponding apertures in the adjacent end of the facing section.

Brief Description of the Drawings

The present invention will be described with reference to the drawings, in which:

Figure 1 is a perspective wireframe view of a hollow turbine blade or vane;

Figure 2 is a cross-section through Figure 1 to show the spacing of an impingement tube from the inner surface of the blade or vane;

Figure 3 is a phantom drawing showing the location of a two-part impingement tube inside a hollow blade or vane; and

Figure 4 is an enlarged view of part of Figure 3, showing cross-sectional detail of an internal chordal rib.

Detailed Description of the Illustrated Embodiments

In the present description, reference will only be made to blades, for the sake of simplicity, but it is to be understood that the invention is applicable to both blades and vanes of a turbine. The skilled man will appreciate that airways can be provided to the interior of either stator vanes or rotor blades for the purpose of air cooling.

As shown in Figure 1, a blade 1 has a complex external aerofoil section for increased efficiency in use. The leading edge 2 is also curved, possibly in multiple directions. The blade is cast, as is well known in the art, so as to have a hollow interior 3. An impingement tube, indicated generally by the arrow 4, is inserted into the hollow for the express purpose of providing a conduit for cooling air.

As shown in Figure 2, the blade is preferably cast with internal ribs 5 extending in the general direction of chords of the aerofoil. The advantage of this is that the ribs provide additional cooling surface area and may serve to guide the cooling air exiting from the impingement tube towards the more heat-critical surfaces of the blade. Eventually, the spent coolant passes from the blade into the surrounding freestream through film holes, slots or other apertures, as known in the art. Some of these may be provided in the trailing edge 6 of the blade. The ribs 5, as can be seen in Figure 3, are not necessarily continuous around the chord of the blade but can be foreshortened or provided in sections.

The ribs 5 create an internal space 7 between the inner surface of the blade and the outer surface of the impingement tube, enabling cooling air to be brought through the impingement tube 4. In the case of rotor blades, cooling air can be brought through the hub or disc and into the impingement tube from the radially innermost end. In the case of stator vanes, cooling air can be brought from one or other or both radial ends of the vane into the impingement tube 4.

In order for the impingement tube 4 to be inserted into the internal space 7 the tube is split into two sections 4a and 4b. Each section is inserted from a respective radial end of the blade towards the middle region of the blade height, height being measured in a radial sense from the innermost to the outermost radial extent of the blade. The sections are welded or otherwise fixed in place within the blade.

One of the ribs 5 at or near the middle height region of the blade is preferably sized to provide a "stop" for the ends of the impingement tube sections 4a, 4b. As shown in Figures 3 and 4, the side of the rib facing towards the impingement tube may be configured to enhance the ability of the rib to locate the impingement tube sections. In its preferred form, the rib is chevron-shaped on the side facing the impingement tube. This provides a more positive location, an interference fit, for the adjacent ends of the sections of the impingement tube. The depth of insertion of the impingement tube sections can be controlled more accurately, e.g. by filing the weld bead. In addition, the shaped rib can be arranged either to minimise leakage of cooling air from between the adjacent ends of the impingement tube sections or, alternatively, by suitable design, can provide a predetermined flow of cooling air into the space between the ends of the impingement tube sections.

One or both of adjacent ends of the impingement tube sections can be closed and cooling can be enhanced by providing the adjacent ends of the impingement tube sections with apertures that allow air to emerge from within the impingement tube sections and to impinge on the inner wall of the blade. Whilst it may be sufficient for these apertures to be normal to the ends, it may be preferable to provide the sections with thicker material at the base so as to allow the apertures to be angled for greater efficiency. Alternatively, the impingement tube sections may be provided with stamped closed ends defining profiled holes at appropriate angles. The direction of holes in the bases should be arranged so that air from the base of one impingement tube section is not directed straight at the holes in the base of the other impingement tube section.

The impingement tube sections may otherwise be provided with features as normally provided in one-piece impingement tubes, such as an array of small diameter holes concentrated near the leading edge thereof. The aerofoil section itself may similarly be provided with conventional and/or known features, such as film holes in the leading and trailing edges to allow air to exit the blade into the external boundary layer and the freestream respectively, and pedestals in the trailing edge to enhance heat transfer.

CLAIMS

1. A turbine blade or vane comprising an impingement tube located generally in a radial direction within the blade or vane, the impingement tube comprising two sections, extending into the blade or vane from opposite radial ends thereof.

2. A turbine blade or vane according to Claim 1, wherein the interior of the blade or vane includes at least one rib adapted to locate the adjacent ends of the sections of the impingement tube.

3. A turbine blade or vane according to Claim 2, wherein the rib is discontinuous.

4. A turbine blade or vane according to Claim 2 or 3, wherein the rib has a chevron-shaped cross-section so as to engage the said adjacent ends of the sections of the impingement tube.

5. A turbine blade or vane according to any preceding claim, wherein at least one of the adjacent ends of the sections has an end wall thereacross.

6. A turbine blade or vane according to Claim 5, wherein apertures are provided in or adjacent to the or each end wall allowing cooling air to exit the sections and impinge on the inner surface of the blade or vane near the mid-height region thereof.

7. A turbine blade or vane according to Claim 6, wherein the apertures are arranged so as not to be disposed opposite corresponding apertures in the adjacent end of the facing section.

8. A turbine blade or vane, substantially as described with reference to, or as shown in, the drawings.

9. An impingement tube for location within a hollow blade or vane of a turbine, the impingement tube comprising two sections adapted to be inserted into the hollow blade or vane from opposite radial ends thereof.

ABSTRACT

IMPINGEMENT TUBES FOR TURBINES

A turbine blade or vane (1) comprises an impingement tube (4) located generally in a radial direction within the blade or vane, the impingement tube comprising two parts (4a and 4b), extending into the blade or vane from opposite radial ends thereof.

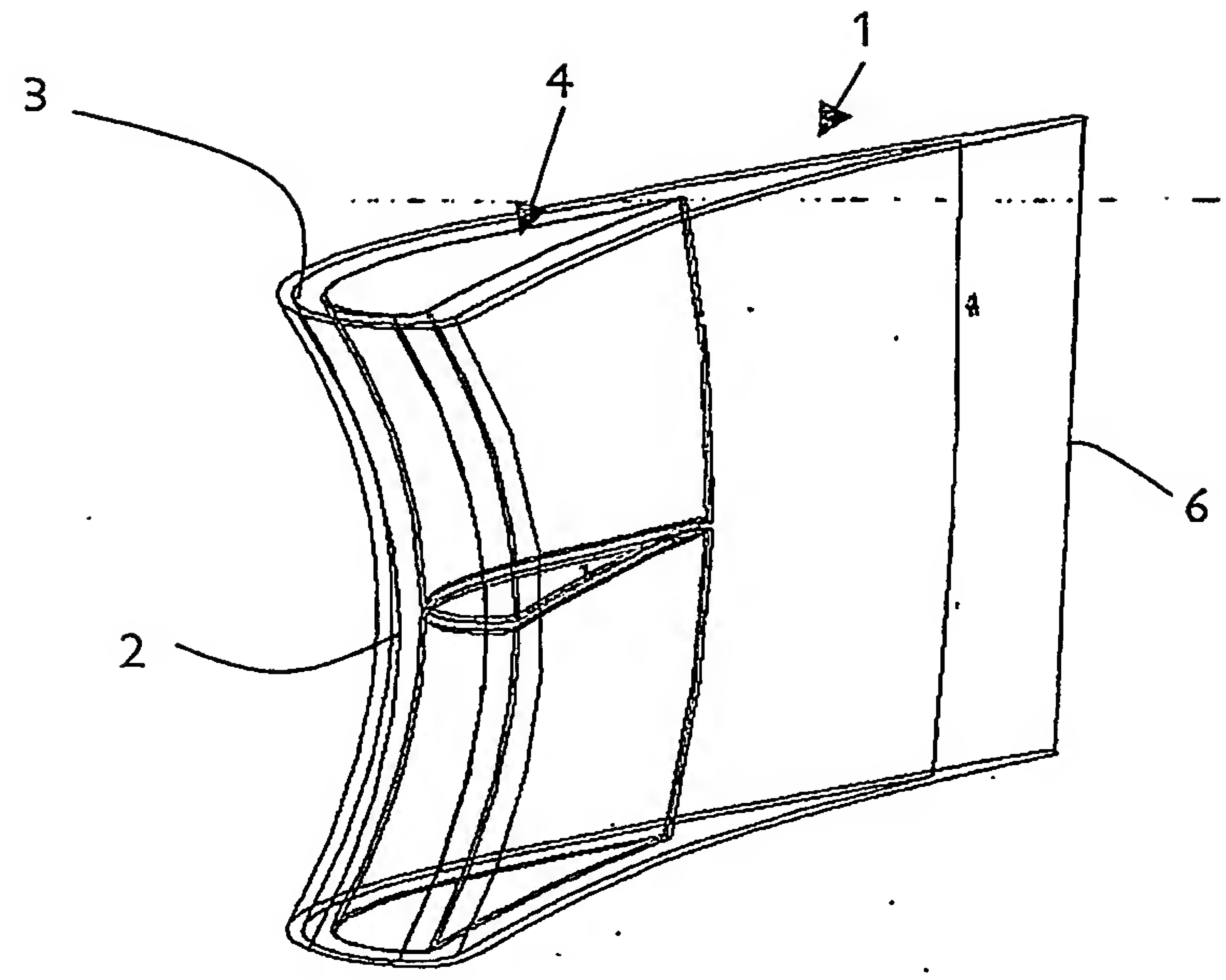

Fig 1

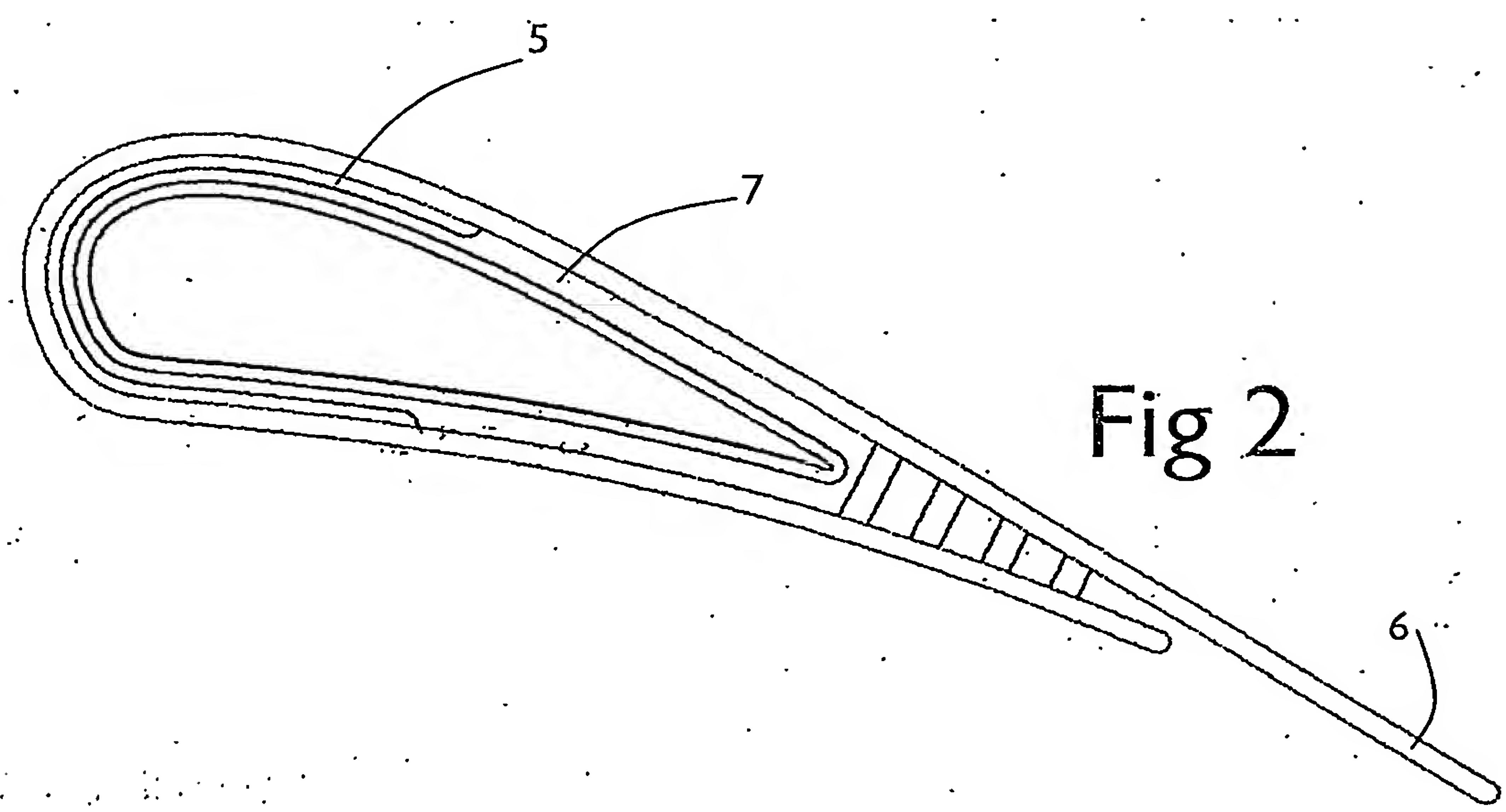

Fig 2

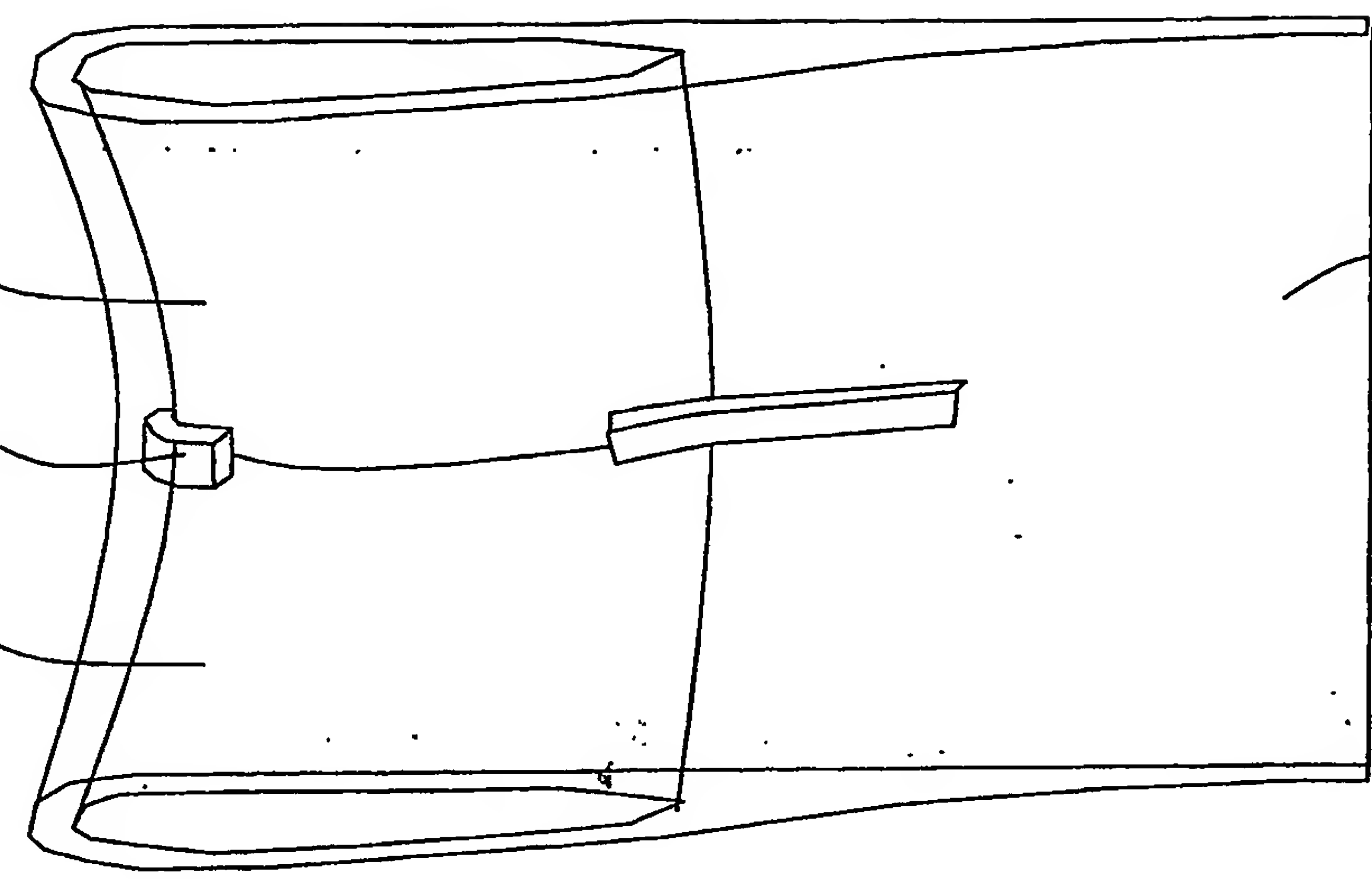

Fig 3

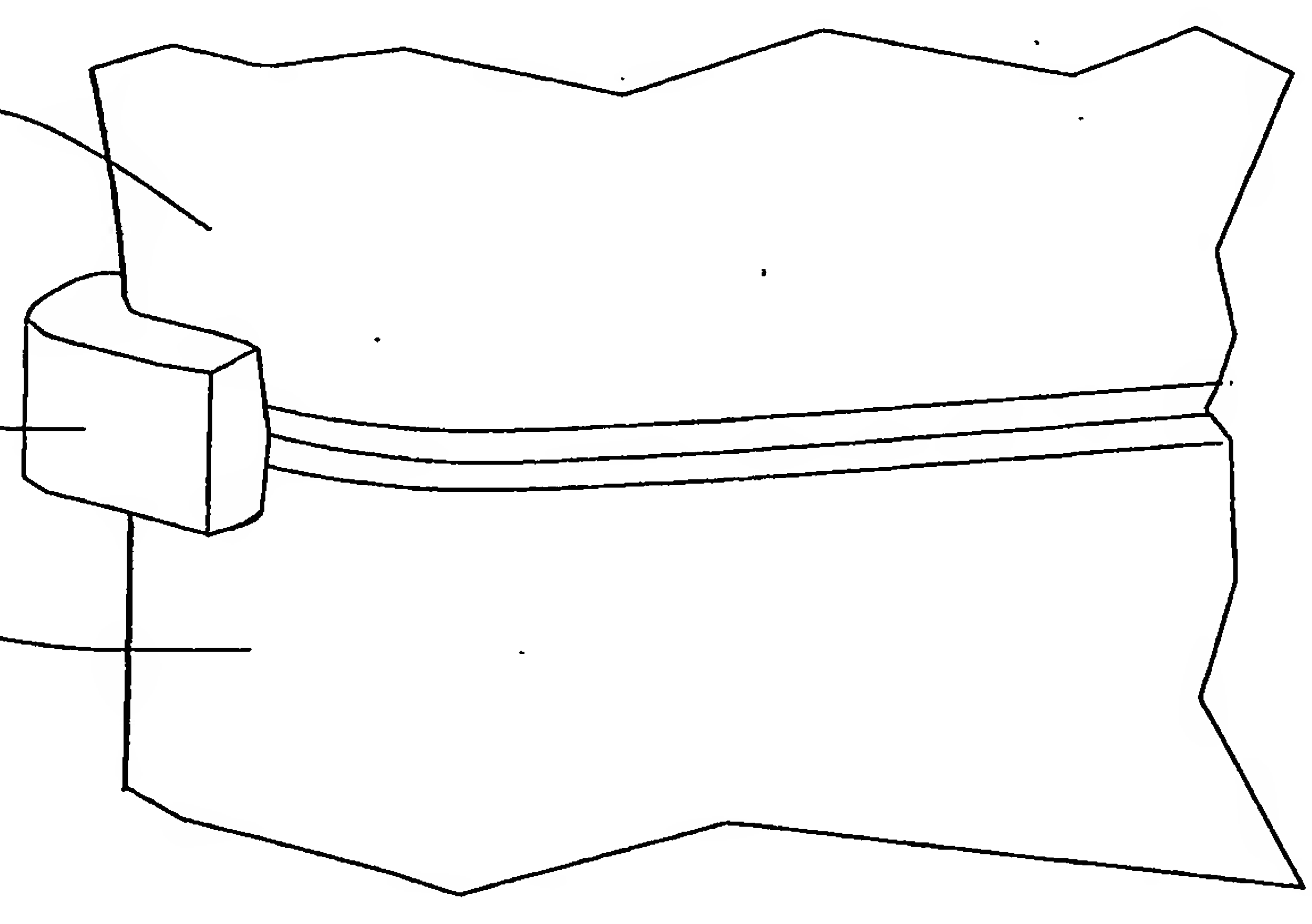

Fig 4

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